Claims

1. A method of distance measurement, wherein pulsed electromagnetic radiation (13) is transmitted using at least one transmitter (11) and reflected signal pulses (15) are detected using at least one receiver (17), wherein the distances from objects (19) at which the transmitted radiation pulses (13) are reflected are measured by determining the pulse propagation time,
characterized in that
the noise is measured using the receiver (17), with points in time (33) being determined at which at least one threshold (21) of the receiver (17) lying in the noise is passed through and with changes in the noise caused by the signal pulses (15) being detected by averaging a plurality of individual measurements respectively including the specific points in time (33).

2. A method in accordance with claim 1, characterized in that an individual measurement is generated for each transmitted radiation pulse (13).

3. A method in accordance with any one of the preceding claims, characterized in that the generation and the averaging of the individual measurements and the detection of the changes in the noise take place by means of a software-aided evaluation method.

4. A method in accordance with any one of the preceding claims, characterized in that a sequence of logical pulses (23) is generated

by means of the threshold (21) of the receiver (17) lying in the noise from the analog received signal (37) containing the noise pulses and/or noise pulses changed by the signal pulses (15), with the individual measurement being derived from this sequence.

5. A method in accordance with claim 4, characterized in that the flanks of the logical pulses (23) are used as points in time (33) of the individual measurement.

6. A method in accordance with any one of the preceding claims, characterized in that the points in time (33) of the individual measurement are introduced into at least one memory (25, 27).

7. A method in accordance with any one of the preceding claims, characterized in that the points in time (33) of the individual measurement are first intermediately stored in a memory (25), in particular in a memory of an IC component (45), and are subsequently transferred to a further memory (27), in particular to a time pattern memory, with the points in time (33) being stored in the further memory (27) in an arrangement taking their respective time information into account.

8. A method in accordance with any one of the preceding claims, characterized in that the averaging of the individual measurements is carried out in at least one time pattern memory (27), with the same time pattern memory (27) preferably being used for all individual measurements to be averaged and with the corresponding memory cell of the time pattern memory (27) being increased by a

value n in the case of a rising pulse flank and being reduced by the value n in the case of a falling flank, or vice versa, with the value 1 preferably being used for n.

9. A method in accordance with any one of the preceding claims, characterized in that a time pattern is used in the averaging of the individual measurements in which the measurement time is divided into a plurality of sequential time windows, with one memory cell of at least one time pattern memory (25, 27) preferably being associated with each time window.

10. A method in accordance with claim 9, characterized in that the number of passing throughs of the threshold (21) of the receiver (17) is counted or averaged, in particular with the correct sign, for each time window in the averaging.

11. A method in accordance with any one of the preceding claims, characterized in that a distinction is made in the averaging between points in time (33) at which the threshold (21) of the receiver (17) is exceeded and points in time (33) at which the threshold (21) of the receiver (17) is fallen below, with preferably a point in time (33) of an exceeding being evaluated as positive and a point in time (33) of a falling below being evaluated negatively, or vice versa.

12. A method in accordance with any one of the preceding claims, characterized in that the average value is integrated into an amplitude function (29) subsequent to the averaging of the individual measurements.

13. A method in accordance with claim 12, characterized in that the bandwidth of the amplitude function (29) is reduced in that averaging is preferably carried out in the amplitude function (29) in each case over a predetermined number of sequential time windows.

14. A method in accordance with claim 12 or claim 13, characterized in that a detection threshold (31) is applied to the amplitude function (29) for the detection of the changes in the noise caused by the signal pulses (15).

15. A method in accordance with claim 14, characterized in that the respective associated object distance is determined in the amplitude function (29) for the signal pulses (15) on the basis of at least one point in time (65) at which the detection threshold (31) is passed through.

16. A method in accordance with claim 14 or claim 15, characterized in that the detection threshold (31) is set in dependence on a factor by which the threshold (21) of the receiver (17) is reduced with respect to a value of 4.5 NEP.

17. A method in accordance with claim 16, characterized in that the detection threshold (31) is calculated from a calculation specification containing the factor.

18. A method in accordance with any one of the claims 12 to 17, characterized in that, in the amplitude function (29) for the determination of nadirs of the signal pulses (15), in each case in the region of the rising flank and/or falling flank of the signal pulse (15), an extrapolation of the noise is carried out, a noise function obtained in this process is deducted from the amplitude function (29) and the point of intersection of the interpolated pulse flank with the average value of the noise is determined as the nadir, with the object distances being determined on the basis of the nadirs.

19. A method in accordance with any one of the claims 14 to 18, characterized in that the shape of the signal pulses (15) is evaluated in the amplitude function (29).

20. A method in accordance with any one of the preceding claims, characterized in that the averaging of the individual measurements takes place packet-wise in that a summing is carried out sequentially in each case via a number of single individual measurements and a division is made by the number of individual measurements for the formation of packet average values.

21. A method in accordance with claim 20, characterized in that the object distances are determined from a single packet average value.

22. A method in accordance with claim 20, characterized in that averaging is carried out over a plurality of packets and the object distances are determined from the average value hereby formed.

23. A method in accordance with any one of the preceding claims, characterized in that an apparatus in accordance with any one of the following claims is used.

24. An apparatus for distance measurement by determination of the pulse propagation time, having at least one transmitter (11) for the transmission of pulsed electromagnetic radiation (13) and having at least one receiver (17) for the detection of reflected signal pulses (15),

characterized in that

the receiver (17) comprises an amplifier (35) for the generation of an analog received signal (37) and a device (39) having at least one threshold (21) lying in the noise with which a sequence of logical pulses (23) can be generated from the analog received signal (37); and

in that an evaluation device (41) is associated with the receiver (17) with which a respective individual measurement can be generated for a plurality of transmitted radiation pulses (13) from points in time (33) which correspond to the flanks of the logical pulses (23) and an averaging of the individual measurements respectively including the determined points in time (33) can be carried out for the detection of changes in the noise which are caused by the signal pulses (15).

25. An apparatus in accordance with claim 24, characterized in that the device with the threshold (21) lying in the noise comprises at least one comparator (39) or at least one limiting amplifier.

26. An apparatus in accordance with claim 24 or 25, characterized in that a clock (43) for the emission of cycle pulses of a known width with a known frequency and a counter with which the cycle pulses emitted during a time period are provided for the determination of time periods which respectively pass from the transmission of a radiation pulse (13) up to a point in time (33) corresponding to a flank of a logical pulse (23).

27. An apparatus in accordance with any one of the claims 24 to 26, characterized in that the measurement time is divided into a plurality of sequential time windows and the evaluation device (41) comprises at least one time pattern memory (27) whose memory cells are each associated with a time window.

28. An apparatus in accordance with claim 27, characterized in that the value of each memory cell is changeable by a pulse flank falling into the corresponding time window, with each memory cell preferably being able to be increased by a rising pulse flank by a value n and, in the case of a falling flank, being able to be reduced by the value n, or vice versa, with the value 1 preferably being provided for n.

29. An apparatus in accordance with any one of the claims 24 to 28, characterized in that the generation and the averaging of the individual measurements as well as the detection of the changes in the noise can be carried out by means of a software-aided evaluation method.

30. An apparatus in accordance with any one of the claims 24 to 29, characterized in that the evaluation device (41) comprises at least one IC component (45) in which at least the generation of the individual measurements can be carried out.

31. An apparatus in accordance with claim 30, characterized in that the evaluation unit (41) comprises at least one microprocessor (47) and at least one interface (49) for the transmission of the generated individual measurements from the IC component (45) into the microprocessor (47), with at least the averaging of the individual measurements and the detection of the changes in the noise being able to be carried out by means of the microprocessor (47) and of at least one memory (27).

32. An apparatus in accordance with any one of the claims 24 to 31, characterized in that it can be operated in accordance with a method in accordance with any one of the claims 1 to 22.